SELECTIVE FEEDING BY WILD DUCKLINGS OF DIFFERENT SPECIES

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At the Delta Waterfowl Research Station at the south end of Lake Manitoba, where this work was done, conditions are very favorable for the study of young ducklings. Eggs of various species are collected from the surrounding marshes and hatched in the laboratory incubator. Thus, newly hatched young of wild heritage were available to us for further study. We studied the diet and feeding behavior of Mallard (*Anas platyrhynchos*), Pintail (*A. acuta*), Blue-winged Teal (*A. discors*), American Widgeon (*Mareca americana*), Gadwall (*A. strepera*), Shoveler (*Spatula clypeata*), Wood Duck (*Aix sponsa*), Redhead (*Aythya americana*), Lesser Scaup (*A. affinis*), and Ruddy Duck (*Oxyura jamaicensis*), both in the laboratory and in the field, and attempted to concentrate our effort on the behavior of downy ducklings during their first week after hatching. An abstract of some of our results and conclusions has been published (Collias and Collias, 1958). The general ecology of the Delta area, with special reference to waterfowl, has been described by Hochbaum (1944). For identification of invertebrates in the marsh we relied mainly on the book by Pennak (1953).

Evidence for selective feeding in the field.—We managed to make some general observations on the mode of feeding in the marsh of from two to six broods each, of several of the above-mentioned species of ducklings in their first week. Ruddy Duck and Lesser Scaup broods of this age fed mostly by diving and straining, Blue-winged Teal by pecking and surface-straining, while Redheads and Mallards quite often used all of these methods.

Differences in feeding methods are associated with differences in bill structure, the extremes being represented by the Ruddy Duck and by the Blue-winged Teal and Wood Duck. Ducklings of the first-named species have very broad flat bills with many well-developed ridges for straining, while in the latter two species the bill is relatively narrow, with poorly developed internal ridges. In ducklings that are more general feeders, such as the Mallard, the bill conformation and structure show an intermediate condition from that seen in the specialists for straining or pecking.

Cottam (1939) and Mendall (1949) examined stomach contents of certain species of ducks, and found that the percentage of animal matter eaten is greatest in the young, and that a much greater proportion of vegetable matter is eaten as the duck grows older. Our examinations of stomach contents (we included proventriculus as well as gizzard in our observations), combined with those of others, suggest possible species differences in diet during the first week, post-hatching. Seven Blue-winged Teal from three different broods and localities had all eaten mainly small snails (*Physa* and *Lymnaea*). Four Ruddy Duck ducklings each had the stomach packed with midge (Tendipedidae) larvae. Cottam had also found that six of ten juvenile Ruddy Ducks had made midge larvae the main item of their meal. Water-boatmen (Corixidae) and amphipods were next in importance. Three Lesser Scaup ducklings we examined had eaten mainly *Chaoborus* larvae. Five Redhead ducklings, one week old, had eaten mainly seeds of the sago pondweed (*Potamogeton pectinatus*). Cottam reported that of three downy young Redheads, two had fed entirely on seeds and other plant material, while one had 93 per cent of animal matter in its stomach, mainly corixids. We found that a Mallard duckling, 10–12 days old, had 43 caddice-fly larvae in the proventriculus, while the gizzard contained many remains of Odonata, including wings of adult dragonflies.

These stomach content analyses help explain the diversity in feeding methods observed. Presumably, midge larvae are frequently secured by diving; snails, amphipods, and most adult and some larval insects, by surface feeding.

Laboratory evidence for selective feeding.—Evidence for different species of ducklings was secured by the following procedure. Ducklings were taken directly from the incubator on hatching, and were trained to follow the human observer (Collias and Collias, 1956). The ducklings became so tame that we could observe their feeding responses as closely as we wished without provoking alarm in them. Usually, from one to three individuals, each one to seven days old, and of different species, were placed in a flat-bottomed, white enamel pan partly filled with water. Into the pan we introduced various invertebrate animals from the surrounding marsh. Between test periods, the ducklings were kept together in a small, indoor pool, where they were fed a mixture of invertebrates, supplemented in some cases by the standard poultry-pellet diet used for raising ducks in the hatchery.

We also conducted some tests in an insect light trap, into which we introduced swarms of midges and other small flies, along with ducklings of different species. This structure was a small boxlike affair with sides and roof of fly-screen, and containing a lamp at one end.

In general, the laboratory observations on ducklings in their first week agreed with the field observations both on the importance of animal food and on selective feeding, but were more precise and extended the results. Thus, hand-raised ducklings of Mallard, Pintail, Blue-winged Teal, American Widgeon, Gadwall, Shoveler, Wood Duck, Redhead, Lesser Scaup, and Ruddy Duck, during their first week after hatching, ate little or no duckweed, but all readily captured and ate many daphnids, amphipods, and various aquatic insects.

There seemed to be two principal modes of securing food: straining and pecking. In straining, water is drawn into the bill near the tip and exits by way of the gape and sides of the bill farther back. In pecking, a duckling abruptly jabs at some object, seizing it in the partly opened bill at the same time, in one well-coordinated movement.

Different species of ducklings, at the age levels tested, used one or both methods of securing food in widely differing degree. For example, Ruddy Duck young fed entirely by straining food organisms from the water, downy Wood Ducks very largely fed by pecking at small invertebrates, and only rarely by straining. Other species were more or less intermediate between these two extremes.

The Ruddy Ducks captured all food organisms in water by straining, including even small fishes; and when placed in a dry cage swarming with midges or other small flies, they proved to be relatively helpless, and did little or no pecking. Once or twice a duckling would jab its bill sideways at the floor in a clumsy fashion but never caught anything. One duckling even tried briefly to strain midges up from the floor of the cage.

In contrast to the ruddies, the ducklings of all other species tested were adept at catching flies. Mallard and Blue-winged Teal were very interested and skillful. The other species were also skillful, but seemed less interested in the flies. It seemed to take a great deal of effort for the Redheads and Shovelers that were tested to swallow an insect once caught, but the Mallards swallowed the flies easily.

Not all aquatic invertebrates were equally available to the various species of ducklings. Good strainers like ruddies or Shovelers could remove zooplankton of smaller size than could most other kinds of ducklings. For example, when a Shoveler, American Widgeon, and Gadwall were placed together in a pan with hundreds of young *Daphnia* which were only ⅕ the size of adult *Daphnia,* the Shoveler soon cleaned up almost all of them alone. The other ducklings scarcely tried to feed, although the Gadwall pecked occasionally at some of the large *Daphnia* and at two or three flies that happened to alight on the edge of the pan. But when offered larger invertebrates, the Gadwall and American Widgeon readily fed on them. On the other hand there is a lower limit to the size of the zooplankton that even good strainers can readily obtain. Microscopic examination of the water after a three-day-old Ruddy Duck had finished feeding revealed the presence of much of the smaller zooplankton, including many ostracods, copepods, bosminid cladocerans, water mites, and recently hatched notonectid bugs. But the duckling did secure some of these animals.

An example of a particular test series may help clarify the nature of selective feeding behavior among ducklings. A Ruddy Duck was placed in a white

Table 1

Counts of Common Aquatic Invertebrates, Other than Snails, Associated with Plants at the Delta Waterfowl Research Station (Summer, 1955)

Plants	Collecting time (min) in field	Number of collecting stations	Amphipods	Insects: Corixidae	Insects: Tendipedidae (larvae)	Other invertebrates
Fluminia	15	4	2	24	487	3
Phragmites	75	5	130	10	100	19
Typha	30	6	784	52	92	7
Lemna	50	5	5,581	157	60	62
Utricularia	55	7	3,271	149	56	293*
Ceratophyllum	15	3	90	301	10	15
Scirpus	190	4	259	7	50	21
Potamogeton pectinatus	35	2	100	116	3	13

* Various dipterous larvae, other than Tendipedidae.

enamel pan partly filled with water and containing hundreds of red *Daphnia* and amphipods. However, this duckling would not feed but gave distress calls until it was given the company of another duckling, a Redhead. Then both ducklings promptly began straining out the *Daphnia,* which were all eaten in about 20 minutes. Precisely with the disappearance of the *Daphnia,* the Redhead stopped straining and began to give distress calls, continuing these for the next 20 minutes. Nevertheless, when this duckling stopped feeding most of the amphipods were still present, having concentrated at the bottom of the pan. Since the Redhead had strained at the surface, the amphipods escaped its attention. But the Ruddy Duck duckling put its bill down into the water more deeply, continued to strain, and caught all the amphipods.

By the end of the first 40 minutes of this test, two large notonectid bugs, present from the start, still eluded both the Ruddy Duck and the Redhead. These two ducklings were now removed, and a Blue-winged Teal duckling was placed in the pan. It actively pursued the notonectids and caught both of them within two minutes. It then jumped out of the pan, walked across the laboratory table to a jar containing two other notonectids and pecked at them through the glass.

Definite species preferences for given food organisms also helped determine selective feeding. We repeatedly observed that Blue-winged Teal ducklings placed in a pan with water fleas and snails, generally ate the snails first. Ruddy Ducks and Redheads under similar conditions ignored the snails and first strained out the water fleas.

Ecological distribution of invertebrate food organisms.—The next step in working out differences in feeding behavior was to see how such differences correlated with the ecological distribution of the principal invertebrate food

TABLE 2
COUNTS OF COMMON SNAILS ASSOCIATED WITH PLANTS AT THE DELTA WATERFOWL RESEARCH STATION (SUMMER, 1955)

Plants	*Lymnaea*	*Physa*	*Helisoma*	*Menetes*	*Valvata*
Fluminia	425	268	1	27	0
Phragmites	69	61	96	0	0
Typha	12	63	0	0	0
Lemna	320	116	7	328	0
Utricularia	2,469	657	19	73	0
Ceratophyllum	13	18	0	0	0
Scirpus	34	21	7	0	0
Potamogeton pectinatus	136	1,163	3	0	102

organisms in the Delta Marsh. Most important of these organisms were the snails, *Physa* and *Lymnaea*, amphipods of the genera *Hyallela* and *Gammarus*, and various insects, particularly corixids and midge or chironomid (Tendipedidae) larvae. These are all predominantly scavengers and their abundance at Delta is correlated with the abundance of organic detritus in the marsh.

Tables 1 and 2 show the distribution of these invertebrates in relation to the principal angiosperm plants of the marsh. The time we spent in collecting necessarily varied greatly with the type of plant being collected, but comparisons of the relative numbers of invertebrates associated with each kind of plant are generally reliable. We tried to collect in places with relatively pure growths of each species of plant, insofar as this was possible.

Whitetop grass (*Fluminia*) was good for snails and midge larvae. Flooded areas of whitetop and ponds with whitetop and sedge margins have been found to be particularly good places for rearing of broods of such ducks as Blue-winged Teal and Ruddy Duck (Sowls, 1955). It seems apparent that the snails particularly attract the teal broods, and the midge larvae the Ruddy Ducks.

Phragmites or reed grass, as Lyle Sowls has remarked, may form dense growths that attract very few nesting ducks, and we found relatively few invertebrates in such dense growths. However, a bottom sample taken with an Ekman dredge in an opening near a *Phragmites* margin, at a place where a brood of downy Ruddy Ducks had been feeding, contained many midge larvae. Cattails (*Typha*) were also relatively poor in their invertebrate life, except that large amphipods were often quite numerous on the dead or decaying roots of cattails that had been flooded out.

It is in small open places within patches of whitetop grass, *Phragmites*, or cattails, that one often finds broods of downy ducklings of various species and it is here that duckweed (*Lemna*) and bladderwort (*Utricularia*) often abound and teem with invertebrate life. Snails, especially *Lymnaea* and *Physa*, as well as amphipods, were most abundant on these plants. Small amphipods would often cling to the roots of duckweed, and it was common to see downy ducklings of Blue-winged Teal and Mallard straining through the duckweed, with the tip of their bills just beneath the surface at the proper depth for capturing amphipods.

Coontail (*Ceratophyllum*) and bulrush (*Scirpus*) in the Delta Marsh appeared to be relatively poor in numbers of invertebrates. Patches of sago pondweed often grow well out in the lake, and despite their exposed situations are favorite feeding places for certain ducks, like the Canvasback (*Aythya valisineria*). Besides the seeds of the sago, there are various invertebrates, of which we observed the snail, *Physa*, to be abundant. One of the brood of Blue-winged Teal collected was feeding on snails in a patch of sago at the time, while a brood of five Redheads that were collected, one week old, had been eating seeds of the sago.

All of the plants listed in Tables 1 and 2 were frequently more or less covered with algae below the water, and patches of algae were often floating near them. Midge larvae were usually numerous in such masses of blue-green algae. Patches of a green alga (*Cladophora*) in duckweed, contained many small *Physa*, immature amphipods and some rotifers, while the algal filaments were studded with diatoms of several species.

Probably the most common invertebrate of a size visible to the unaided eye, in the Delta Marsh in the summer of 1955, was a red form of *Daphnia magna*, which swarmed in all the small openings as well as in the open bays, often feeding on a blue-green alga (*Microcystis*) that at times occurred in immense blooms, coloring the water a continuous green against which could be seen the red streaks and clouds of *Daphnia*. These red *Daphnia* often clustered about submerged vegetation such as bladderwort, and could be picked up by the thousands in one sweep of the dip net.

The density of *Daphnia* was sampled by dipping up with a pail 100 liters of water, over a random course once a week, from the open water of a small bay near the research station. A count was made of the 10 August sample, using the methods described by Welch (1948:285–288). From this sample we computed a density of 129 individual *Daphnia* per liter of water. In comparison, the largest density of *Daphnia*, sampled on 13 July, amounted to more than 1,000 individuals per liter. The daphnids on this day were even more abundant than in the preceding week, when the plankton net had become clogged with water fleas after being dragged behind the boat only 50 yards.

Daphnia appeared to us to be one of the most general foods available and acceptable to downy waterfowl. All of the ten species of incubator-hatched ducklings that we tested readily ate the water fleas. The average peak of hatch

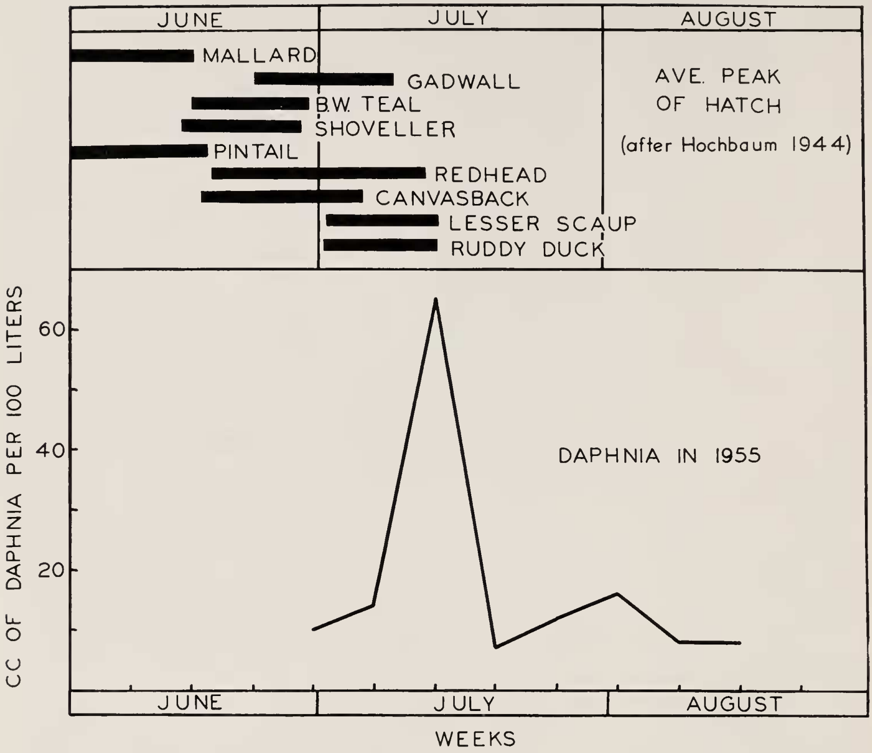

FIG. 1. Comparison of time of duckling hatch and population sizes of *Daphnia*.

of most species of ducks at the Delta Marsh comes shortly before the peak of *Daphnia* numbers (Fig. 1), as we observed the latter in sampling one part of the Delta Marsh in the summer of 1955. This was a late season with extreme floods, and the coincidence of broods with *Daphnia* in 1955 was closer than depicted by this diagram. The significance of the correspondence of the peak of cladoceran populations with peak abundance of downy ducklings is evident. Soon after most of the ducklings hatch, there is available to them this important and general food supply.

Caddice-flies, of the families Phryganeidae and Leptoceridae, were also very common. Invertebrates common in various parts of the marsh, but apparently utilized as food by the ducklings very little or not at all, included sponges, hydra, rhabdocoel flatworms (*Microdalyella, Mesostoma, Typhloplana, Stenostomum*), rotifers, gastrotrichs, clams, oligochaetes (*Stylaria*), leeches (*Helobdella, Glossiphonia, Placobdella, Dina, Theromyzon*), and various water mites. Some of the smaller crustaceans of the zooplankton were numerous but were so small that apparently they were not much utilized by the ducklings, including such crustaceans as copepods, ostracods, and various tiny cladocerans (*Bosmina, Kurzia, Pleuroxus, Chydorus*).

Invertebrates in the water were not the only potentially very rich source of food for young ducklings. During the summer of 1955, the biggest flight and emergence of midges that we observed came on 30 July, at which time 900 midges, or 30 cc, were collected in two minutes just by waving an insect net in the air. Spectacular aggregations of various other Diptera as well as dragon-flies (*Aeshna, Sympetrum*), and damsel-flies (*Lestes, Coenogrion, Enallagma, Nehalennia*) were also frequent during the summer.

Although red daphnids were often abundant in large bays in the Delta Marsh, such as Cadham Bay, the larger invertebrates generally associated with plant life were scarce or absent in the open water. Also, a bottom sample from the middle of Cadham Bay in the summertime contained merely old shells and no midge larvae. Downy ducklings do not ordinarily venture out into the open bay far from cover—the food scarcity provides another reason, besides the absence of cover.

In marked contrast to the great abundance of invertebrate food organisms for ducklings in the Delta Marsh, was the relative scarcity of such invertebrates in the waters of Lake Manitoba itself, on the other side of the sandy ridge that separates the lake from the marsh. The paucity of the lake fauna was in large part due to the virtual absence of duckweed and bladderwort with their rich invertebrate fauna. In addition, the *Phragmites* along the lake shore were much poorer in food organisms for ducklings. In 35 minutes of collecting, only 14 snails, 55 amphipods and 8 insects were secured from two *Phragmites* stations in Lake Manitoba; while in 35 minutes of collecting in *Phragmites* at two stations in the marsh, we secured 212 snails, 175 amphipods, and 13 insects. In the open water of the lake there were no red *Daphnia magna*, and the zooplankton consisted largely of copepods with some *Daphnia pulex* and rotifers. Broods of small downy ducklings are ordinarily not to be seen on the waters of Lake Manitoba.

SUMMARY

Downy ducklings, whether hatched in an incubator or in the field, readily eat invertebrate animals, and there is evidence that different species of ducklings tend to specialize on different kinds of invertebrates, despite considerable overlap in diet. These diet differences are related to differences in feeding behavior and in bill structure.

Duckweed and bladderwort contained the greatest number of invertebrate food organisms. The distribution of broods of ducklings is roughly correlated with the abundance of the invertebrates that apparently comprise the main food of many species of ducklings in their first week after hatching.

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